

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
8 December 2005 (08.12.2005)

PCT

(10) International Publication Number  
**WO 2005/115581 A1**

(51) International Patent Classification<sup>7</sup>: **B01D 29/23**

(21) International Application Number:  
PCT/US2005/013169

(22) International Filing Date: 18 April 2005 (18.04.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
60/571,775 17 May 2004 (17.05.2004) US

(71) Applicant (for all designated States except US):  
**PARKER-HANNIFIN CORPORATION** [US/US];  
Parker-Hannifin Corporation, 6035 Parkland Boulevard,  
Cleveland, Ohio 44124-4141 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **MILLER, Daniel W.**  
[US/US]; 4432 Garling Road, Luckey, Ohio 43443 (US).

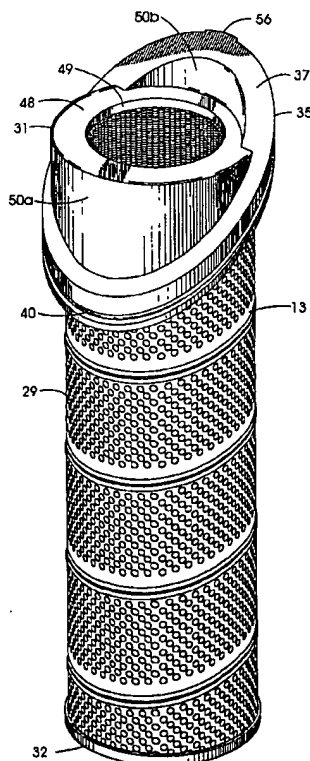
(74) Agents: **HUNTER, Christopher H.** et al.; Parker-Hannifin Corporation, 6035 Parkland Boulevard, Cleveland, Ohio 44124-4141 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,

[Continued on next page]

(54) Title: **FILTER ELEMENT WITH OFF-AXIS END CAP**



(57) Abstract: A filter (10) includes a filter element (13) with an enlarged end cap (31) at one end of a media ring (29) with an elliptical flange (35) set oblique or angled to the longitudinal axis "A" of the element. The flange (35) carries a sealing element (40), and is closely and sealingly received in a head casting (11) of the filter (10) to divide the head casting (11) into inlet and outlet partitions (42, 43). The end cap (31) directs fluid from a transverse port (20) in the housing (12) into an axial flow path into the central cavity (30) of the element, where the fluid flows radially outward through the media (29), and then out through an opposite transverse port (21) in the head casting (11). The element (13) can be removed when it is spent from the head casting (11) after removal of an end closure (24).



FR, GB, GR, HU, IE, IS, IT, LU, MC, NL, PL, PT, RO,  
SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,  
GQ, GW, ML, MR, NE, SN, TD, TG).

— with amended claims and statement

**Published:**

— with international search report

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## **FILTER ELEMENT WITH OFF-AXIS END CAP**

The present invention relates to fluid filters and more particularly to a hydraulic filter.

Hydraulic filters are commonly used as suction line filters, return line filters and pressure filters. One known filter is shown and described in Patent Specification US-A-4,272,368, owned by the assignee of the present invention, in which a two piece housing is provided consisting of a head casting and an elongated, tubular filter container. A tubular filter element, having annular end caps sealingly bonded at each end of a ring-shaped media, is removeably located in the container. A diverter structure provides means for separating the head casting into inlet and outlet partitions in fluid communication respectively with the inner and outer portions of a tubular filter element. The diverter is in a truncated funnel-shaped configuration mounted at its larger periphery within a cylindrical cavity in the head casting. The diverter structure is removable through an open end of the head casting after removal of a cover member, and provides an efficient means for transmitting fluid flow between a transverse port of the housing and the axially-aligned filter element.

The smaller, necked-down end of the funnel-shaped diverter is removeably and sealingly received in one of the annular end caps of the element, and directs fluid flow into the interior of the filter element. The flow passes through the element where particulate and other contaminants are removed, and then passes out through an opposite transverse port in the head casting. The other annular end cap of the filter element is supported by a support member at the opposite, distal end of the container, which can be fixed to removable. The element can be removed when it is spent from the distal end of the container by separation from the diverter; or alternatively can be removed when the diverter is removed from the head casting, and then separated from the diverter.

While the filter described above has received acceptance in the market and provides a number of benefits for the user, it requires a separate diverter component, which adds cost to the system, complexity in manufacture and assembly, and also reduces

the surface area of the media available for filtration. As such, it is believed there is a demand in the industry for a filter, particularly for hydraulic fluid, which has few components, is simpler to manufacture and assemble, and which includes increased surface area for filtration.

5           According to one aspect of the present invention there is provided a filter assembly including a housing enclosing a filter element, the housing including a head and a container, the head having transverse inlet and outlet ports, the filter element including a ring of media defining a central cavity and circumscribing a central longitudinal axis, the filter element bounded at one end by a first end cap, and at an opposite end by a  
10           second end cap, the first end cap including an annular, radially-outward projecting flange extending in a plane at an oblique angle to the longitudinal axis of the filter element and circumscribing at least a portion of the filter element, the flange carrying an annular resilient sealing element, also at the oblique angle, and closely and sealingly received in the head of the filter housing to divide the head into inlet and outlet partitions, whereby  
15           the first end cap directs fluid from the inlet port in the housing into an axial flow path into the central cavity of the filter element, where the fluid flows radially outward through the media ring, and then out through the outlet port.

          The present invention provides a novel and unique filter, particularly for hydraulic fluid, which has few components, is simple to manufacture and assemble, and includes  
20           increased surface area for filtration.

          According to the present invention, the filter includes a filter element with an enlarged end cap at one end of the media ring with an elliptical flange set oblique or angled to the longitudinal axis of the element. The end cap carries a sealing element, also angled to the longitudinal axis, and is closely and sealingly received in the head casting  
25           of the filter to divide the head casting into inlet and outlet partitions. The end cap functions similar to a diverter, in that it directs fluid from a transverse inlet port in the housing into an axial flow path into the central cavity of the element, where the fluid can then flow radially outward through the media to separate particulate and other

contaminants, and then flow out through the opposite transverse outlet port in the head casting.

A support member at the opposite distal end of the container supports the other annular end cap of the filter element. The element can be removed when it is spent from  
5 the open end of the head casting after removal of the cover member. A spring tab can be provided on the flange, which is engaged by the cover member to urge the element into fluid tight engagement with an internal ledge in the head. In addition, a handle can be provided in the first end cap of the element to facilitate removal from the head.

10 The filter element includes a larger extent of media than in prior designs, as the media can extend up into the head casting, thereby increasing the overall surface area available for filtration.

As such, the present invention provides a novel and unique filter, particularly for hydraulic fluid, which has few components, is simple to manufacture and assemble, and includes increased surface area for filtration.

15 The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a side view in cross-section, of a filter constructed according to the principles of the present invention;

20 Figure 2 is an elevated perspective view of the filter element for the filter of Figure 1;

Figure 3 is a side view of the filter element, with a portion in cross-section;

Figure 4 is a rear view of the upper portion of the filter element;

Figure 5 is a top plan view of the filter element;

Figure 6 is a bottom plan view of the filter element; and

25 Figure 7 is an elevated perspective view of the filter element according to a further aspect of the present invention.

Referring to the drawings, and initially to Figure 1, a filter constructed according to the present invention is indicated generally at 10. The filter includes a generally tubular head casting 11 and a tubular filter container 12 which together form an enclosure

or housing for a filter element 13. The container 12 includes an annular flange piece 14 at one end welded to the container 12. The flange 14 has arcuate slots therein (not shown) for receipt of mounting bolts 15 engaging threaded holes in a flange portion 16 of the head casting 11 to provide a quick-release fastening arrangement. An O-ring seal 18  
5 between the flanges 14, 16 provides a fluid seal.

The head casting 11 includes an inlet port 20 and outlet port 21, generally in alignment with one another and both disposed substantially transverse to the longitudinal axis of the tubular housing 12. The head casting 11 comprises a generally cylindrical inner surface 22 extending therethrough, being closed at one end by concave cover  
10 member 24 secured in place at its periphery by bolts 25 in a quick change slotted arrangement similar to that of the mounting flange of the filter housing 12 secured by bolts 15. The distal end of the filter housing 12 is fitted with a cup-shaped closure member 26, welded at its periphery to the end of the housing 12, the closure member 26 further including a central closed end tubular projection 27 which serves as a support  
15 member.

The head casting and container above are preferably substantially as shown and described in Patent Specification US-A-4,272,368, which is incorporated herein by reference.

Referring now to Figures 2-5, the filter element 13 includes a ring of filtration  
20 media 29 circumscribing a central cavity 30, and bounded at its ends by a first, enlarged end cap 31, intended to be located in the head casting; and an opposite, somewhat radially-smaller end cap 32. The first end cap 31 has a radially-outwardly projecting mounting flange 35. Flange 35 is generally an oblique section of a cylinder conforming to the inner surface 22 of the head casting 11 and extends in a plane set oblique or angled  
25 (preferably at 45 degrees) to the longitudinal axis "A" of the element. The flange 35 is substantially an annulus in the form of an ellipse having the longer axis lying in the plane of the paper. The flange 35 includes an upper or outer elliptical flat surface or edge 37, and an oppositely facing lower or inner elliptical flat surface or edge 38, extending parallel to edge 38. The flange 35 carries an annular resilient sealing element 40, located

in a peripheral groove or channel intermediate the upper and lower edges 37, 38, and preferably slightly closer to lower edge 38. Sealing element 40 is closely and sealingly received in the head casting 11 of the filter (see Fig. 1) to divide the head casting into fluidly-separated inlet and outlet partitions 42, 43.

5       The end cap 31 further includes a flat annular portion 48 defining a central opening 49, located in a plane normal to the longitudinal axis of the element and sealingly bonded to the end of the media ring in a known manner, such as with adhesive potting compound; and upper and lower imperforate cylindrical portion 50a and 50b, interconnecting the annular portion 48 and the flange 35, with cylindrical portion 50a  
10       closely surrounding the media. Flow through the inlet port 20 impacts one of the cylindrical portions 50a, 50b, which reduces the energy of the fluid, and slows its velocity, before the flow enters the central opening 49 in the filter element. The axial length of cylindrical portion 50a can vary depending upon the desired or acceptable pressure drop of fluid through the filter, and preferably the cylindrical portion 50a  
15       extends to about the midpoint of the inlet opening 20. The upper end cap 31, including flange 35 and cylindrical portion 50, is preferably formed in one piece (e.g., molded) as a unitary component from an appropriate material (e.g., plastic).

      The inner surface 22 of the head casting consists of a larger diameter portion 51 providing clearance for the end cap 31 and a reduced diameter seating portion 52 forming  
20       a seal seating portion, joined by a bevel 53. The head casting 11 is a die cast aluminum part and requires no further finishing for the internal surfaces thereof, including the seal seating portion 52 and the lead-in bevel 53. An internal annular ledge 54 encircles the entire inner surface of the head casting at an oblique angle, generally extending from just outside the outlet port 21 to toward a location inside the inlet port 20. The cover member  
25       24 which is in sealed engagement with the head casting 11 by means of O-ring 55 may engage the outer portion of the flange 35 or be slightly spaced therefrom, as shown, to retain the element 13 in a seated position. A projection at 56 on flange 35 and a mating notch in inner surface 22, assure proper orientation between the element 13 and the head casting 11 so that the element is concentric with the longitudinal axis of the container 12.

Alternatively or in addition to projection 56, a spring tab 57 can be provided on the flange 35, such as at the outermost portion of the flange, as shown in Figure 7. Cover member 24 engages the distal end of spring tab 57 when installed on the head casting to urge the filter element axially inward against ledge 54, and thus facilitate providing a fluid-tight seal between the element and housing.

The filter element 13, thus may be readily removed from or inserted in the head casting 11 by non-rotative axial movement, with the bevel 53 providing an initial compression of the seal 40 upon insertion. Engagement of projection 56 in its mating notch (and/or compression of spring tab 57) and the geometry of the seating parts of the flange 35 and ledge 54 provide the proper orientation and axial location for the element.

As can be seen in Figure 1, when the filter element 13 is located in the head casting 11, the upper flange surface 37 forms a shelf or shoulder, which can collect particulate matter from fluid impacting the cylindrical portion 50, and thus function as an initial separator device, before the fluid enters the central opening in the filter element.

The end cap 31 functions similar to the diverter referenced in the '368 patent, in that it directs fluid from the transverse inlet port 20 in the housing into an axial flow path into the central cavity 30 of the element 13, where the fluid can then flow radially outward through the media 29 to separate particulate and other contaminants, and then flow between the media and the container, and out through the opposite transverse outlet port 21 in the head casting.

The media 29 for the filter element is illustrated as being an open mesh or weave 58, formed into pleated layers extending in the longitudinal direction, and bounded on its outer surface by a perforated spiral or helical wrap 59. For many hydraulic applications, the components of the element would be formed by a metal such as stainless steel, however it should be appreciated that the filter element of the present invention could be formed in a variety of manners, and from a variety of materials. It could be a depth filter, surface filter, pleated, self-supporting ("coreless"), or in any number of known configurations and materials.



Referring now to Figures 3 and 6, the opposite end cap 32 of the filter element also includes a flat annular portion 60 defining a central opening 61, located normal to the longitudinal axis of the element and sealingly bonded to the opposite end of the media ring in a known manner, such as with adhesive potting compound. A conical portion 64 projects axially inward from annular portion 60 to an annular support flange 66, projecting radially inward from the inner distal end of the conical portion to define a central aperture, smaller in diameter than the opening 61, and concentric with the longitudinal axis of the element. Annular support flange 66 retains a bypass valve, indicated generally at 70, centrally within the element, which allows fluid to by pass a spent or clogged element to retain the functioning of the hydraulic system. By pass valve 70 is illustrated as including a cylindrical body 71 enclosing a spring 73 and a bypass valve member 75, biased into a closed position (illustrated) by spring 73 against a valve seat. Fluid pressure against valve member 75, such as when the element is clogged, tends to open valve member 75 against spring 73 and allow fluid to by pass the element.

Bypass valve 70 is retained within the filter element preferably by one or more threads, which are received in and engage the central aperture of the flange 66, or by other means, such as press-fit, or adhesive. Alternatively, bypass valve 70 could be located in cylindrical portion 50b of the upper end cap 35. In any case, bypass valve 70 is preferably substantially as shown and described in U.S. Patent No. 4,815,493, which is also incorporated herein by reference.

End cap 32 further includes a series of longitudinally extending and radially-inward projecting vanes as at 79, evenly spaced around the inner diameter of conical portion 64, and extending from opening 61 to annular support flange 66. The vanes provide support for the end cap, and particularly the annular support flange 66; and well as properly locate the element on the projection 27 of the closure member 26 and provide flow paths between the bypass valve and around the closure member 26 in the event of filter element bypass. The number and spacing of vanes can vary depending upon the particular application.

End cap 32, including annular portion 60, conical portion 64, vanes 79 is likewise formed in one piece as a unitary component from e.g., plastic, using conventional processes, e.g., molding.

5 It should be appreciated upon viewing Figure 1 that the unique structure of the filter element of the present invention enables the media to extend upwards of the container portion of the filter – into the head casting. This provides additional surface area for filtration, and is dissimilar from the known filters, which, because of the use of bulky diverters which consume the available space in the casting head, contain the media substantially only within the container portion of the filter (see, e.g., Patent Specification  
10 US-A-4,272,368).

Fluid flow is through inlet port 20, down into the central cavity of the element, radially outward through the media 29 where particles and other contaminants are removed, upward between the outer surface of the element and the container, and out through the outlet port 21. While the filter element is described above as being useful  
15 for filtering hydraulic fluid in a hydraulic fluid system, it should also be appreciated that the element could likewise be useful in other types of fluid systems, with appropriate choice of media.

When it is necessary to remove a spent filter element, the bolts 25 and cover member 24 (Figure 1) are removed, and the element is removed through the open upper  
20 end of the head casting. To facilitate removal, a handle, such as shown at 80 in Figure 7, can be provided. Handle 80 has a generally curved configuration formed unitary with, and extending from side-to-side of the annular portion 48 of the end cap 31, and is generally large enough to facilitate grasping, and yet small enough to reduce pressure drop and obstruction of flow. Other handle configurations are possible.

25 As described above, the present invention provides a novel and unique filter, particularly for hydraulic fluid, which has few components, is simple to manufacture and assemble, and includes increased surface area for filtration.

The principles, preferred embodiments and modes of operation of the present invention have been described in the foregoing specification. The invention which is

intended to be protected herein should not, however, be construed as limited to the particular form described as it is to be regarded as illustrative rather than restrictive. Variations and changes may be made by those skilled in the art without departing from the scope and spirit of the invention as set forth in the appended claims.

**CLAIMS**

What is claimed is:

- 1     1.     A filter element (13) including a ring of media (29) defining a central cavity (30)  
2     and circumscribing a central longitudinal axis "A", the filter element (13) bounded at one  
3     end by a first end cap (31), and at the opposite end by a second end cap (32), the first end  
4     cap (31) including an elliptical, radially-outward projecting flange (35) extending in a  
5     plane at an oblique angle to the longitudinal axis "A" of the filter element (13), the flange  
6     (35) carrying an annular sealing element (40), also at the oblique angle to the axis "A".
- 1     2     The filter element (13) as in claim 1, wherein the flange (25) has an outer  
2     dimension larger than the outer diameter of the media ring (29), and outwardly surrounds  
3     at least a portion of the media ring (29).
- 1     3.     The filter element (13) as in either of the previous claims, wherein the annular  
2     flange (35) of the filter element (13) includes an outwardly-facing flat surface (37), and  
3     an opposite, inwardly-facing flat surface (38), parallel to the outwardly-facing flat surface  
4     (27).
- 1     4.     The filter element (13) as in any of the previous claims, wherein the first end cap  
2     (31) further includes a flat annular portion (48) in a plane normal to the longitudinal axis  
3     "A" and defining a central opening (49) into the central cavity (30) of the filter element  
4     (13), the annular portion (48) intersecting the annular flange (35), and imperforate  
5     cylindrical portions (50a, 50b) interconnecting the annular flange (35) and the annular  
6     portion (48) of the first end cap (31).
- 1     5.     The filter element (13) as in claim 4, wherein the annular portion (48) bisects the  
2     annular flange (15), and one cylindrical portion (50b) is a concave portion extending

3 outwardly away from the annular portion (48); while another cylindrical portion (50a) is  
4 a convex portion surrounding a portion of the media ring (29).

1 6. The filter element (13) as in claim 1, further including a handle (80) connected to  
2 the annular portion (48) and extending across the central opening (49) from one side of  
3 the central opening to the other.

1 7. The filter element (13) as in claim 1, further including a spring tab (57) on an  
2 outer portion of the flange (35).

1 8. A filter assembly (10) including a housing (11, 12) enclosing the filter element  
2 (13) of claim 1, the housing (11, 12) including a head (11) and a container (12), the head  
3 (11) having transverse inlet and outlet ports (20, 21), the sealing element (40) of oblique  
4 flange (35) of the filter element sealing along the housing (11, 12) and dividing the head  
5 (11) into inlet and outlet partitions (42, 43), whereby the first end cap (31) can direct fluid  
6 from the inlet port (20) in the housing (11, 12) into an axial flow path into the central  
7 cavity (30) of the filter element (13), where the fluid can flow radially outward through  
8 the media ring (29), and then out through the outlet port (21).

1 9. The filter assembly (10) as in claim 8, wherein the head (11) includes an inner  
2 cylindrical surface (22) with a ledge (54) encircling the surface (22) at an oblique angle,  
3 the ledge (54) facing outwardly from an open end of the head (11), the oblique flange  
4 (35) of the filter element (13) being located against the ledge (54) to axially locate the  
5 element (13) within the housing (11, 12).

1 10. The filter assembly (10) as in either claim 8 or 9, wherein the housing includes a  
2 cover member (24), removably attached to the head (11) and enclosing the open end, and  
3 which can be removed to enable access to the element (13) and removal of the element

4 (13) from the open end of the head (11), wherein the ledge (54) remains with the head  
5 (11) when the cover member (24) is removed.

1 11. The filter assembly (10) as in claim 10, further including spring tab (57) on an  
2 outer portion of the flange (37), the cover member (24) engaging the spring tab (57) when  
3 attached to the head (11) and urging the flange (37) into sealing relation with the ledge  
4 (54).

1 12. The filter assembly (10) as in claim 8, wherein the first end cap (31) has an  
2 annular portion (48) in a plane normal to the longitudinal axis "A" of the element, and  
3 intersecting the annular flange (35), and convex and concave imperforate cylindrical  
4 portions (50a, 50b), extending between the annular portion and the flange, the convex  
5 portion (50a) facing inlet port (21) so as to block a portion of the flow entering the inlet  
6 port (21) to reduce the energy of the flow.

**AMENDED CLAIMS**

**[received by the International Bureau on 12 October 2005 (12.10.05);  
original claims 1, 3, and 4 amended; remaining claims unchanged (1 page)]**

What is claimed is:

1        1.        A filter element (13) including a ring of media (29) defining a central cavity (30)  
2        and circumscribing a central longitudinal axis "A", the filter element (13) bounded at one  
3        end by a first end cap (31) with a flat annular portion (48) normal to the longitudinal axis  
4        "A", and defining a central opening (49) into the central cavity (30) of the filter element  
5        (13), and at the opposite end by a second end cap (32), the first end cap (31) including an  
6        elliptical, radially-outward projecting flange (35) extending in a plane at an oblique angle  
7        to the longitudinal axis "A" of the filter element (13), the flange (35) carrying an annular  
8        sealing element (40), also at the oblique angle to the axis "A".

1        2        The filter element (13) as in claim 1, wherein the flange (25) has an outer  
2        dimension larger than the outer diameter of the media ring (29), and outwardly surrounds  
3        at least a portion of the media ring (29).

1        3.        The filter element (13) as in either of the previous claims, wherein the annular  
2        flange (35) of the filter element (13) includes an outwardly-facing flat surface (37), and  
3        an opposite, inwardly-facing flat surface (38), parallel to the outwardly-facing flat surface  
4        (27), and the annular seaing element (40) is an elastomeric sealing element located in a  
5        peripheral groove circumscribing the outer periphery of the flange.

5        4.        The filter element (13) as in any of the previous claims, wherein the annular  
6        portion (48) [intersecting] intersects the annular flange (35), and imperforate cylindrical  
7        portions (50a, 50b) interconnect the annular flange (35) and the annular portion (48) of  
8        the first end cap (31).

1        5.        The filter element (13) as in claim 4, wherein the annular portion (48) bisects the  
2        annular flange (15), and one cylindrical portion (50b) is a concave portion extending

**STATEMENT**

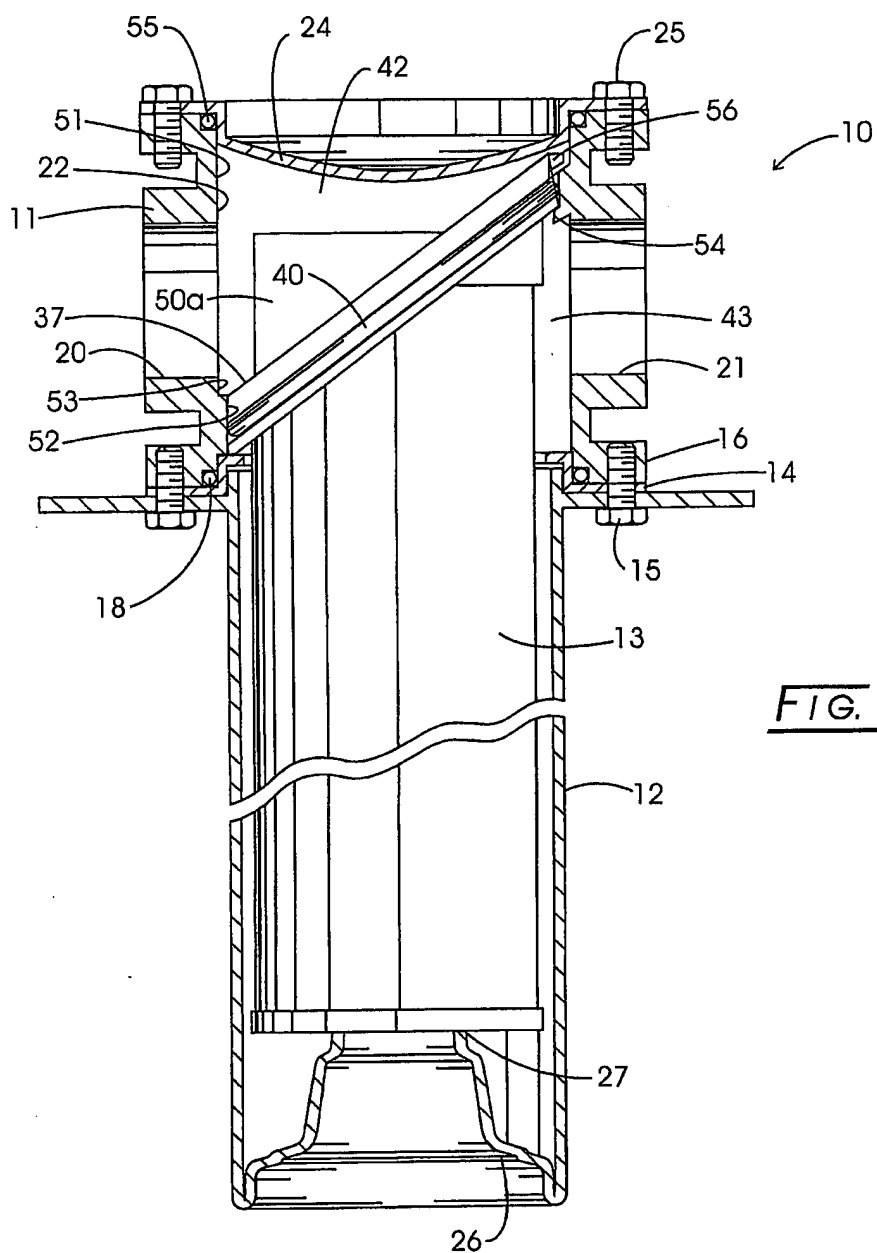
In response to the International Search Report and Written Opinion mailed 19 September 2005, certain changes have been made to claims 1, 3 and 4.

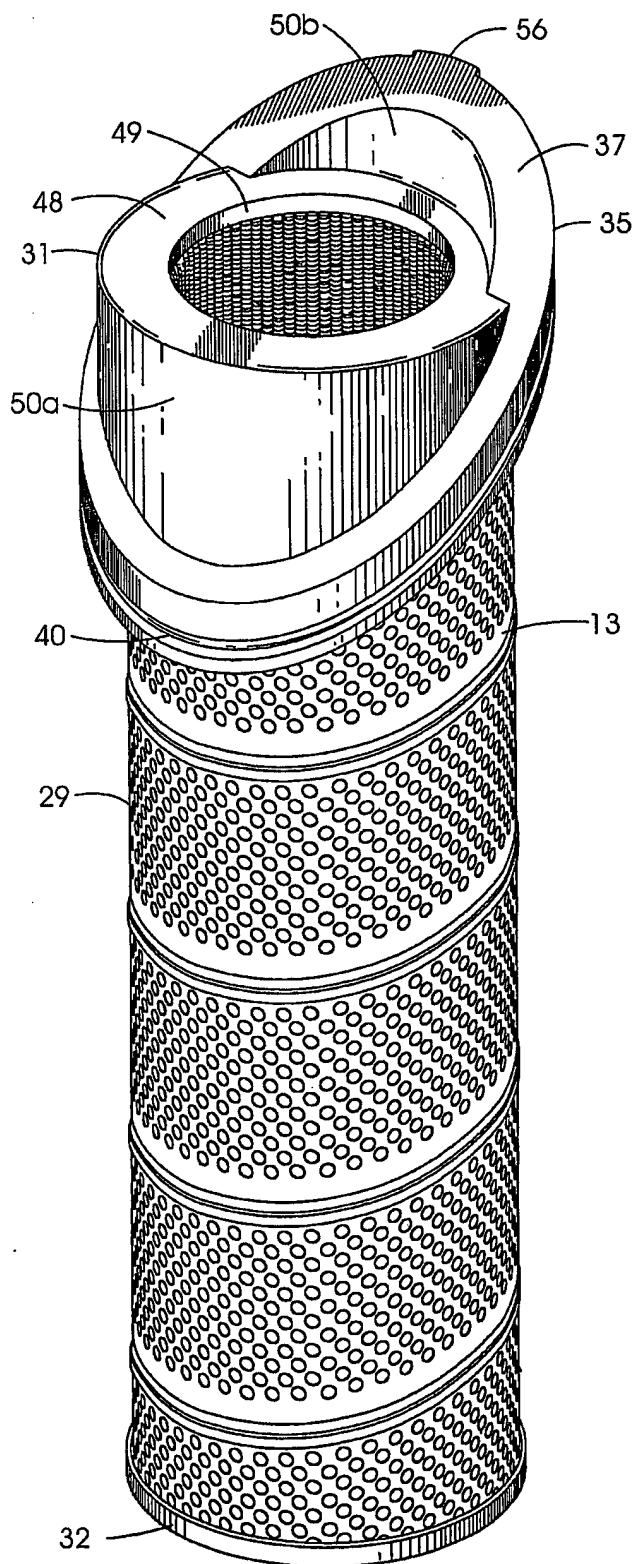
Claim 1 now brings out the flat annular portion (48) of the first end cap (31), and that it is located normal to the longitudinal axis "A" of the media ring (29). This defines over the art, as the art appears to all relate to inlet strainers which have a lip oriented at an oblique angle to the longitudinal axis of the strainer. As further brought out in claim 4, the cited art also does not show the cylindrical portions (50a), (50b) which interconnect the annular flange (35) and the annular portion (48) of the first end cap (31); the cylindrical portions reduce the energy of the fluid, as brought out on page 5, lines 10-15.

Claim 3 now also brings out in greater detail the location of the annular sealing element (40). This is also not shown and described in the cited art.

A favorable examination report is respectfully requested.





FIG. 2

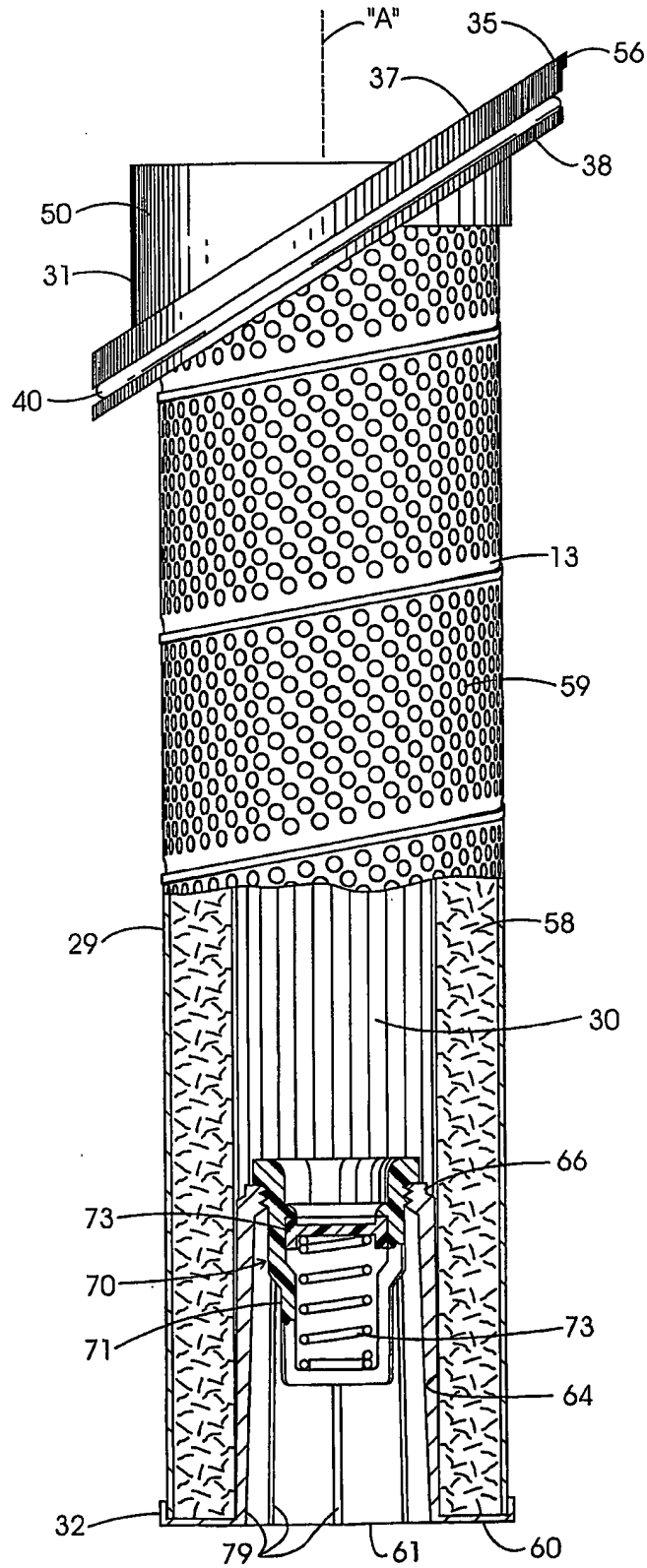


FIG. 3

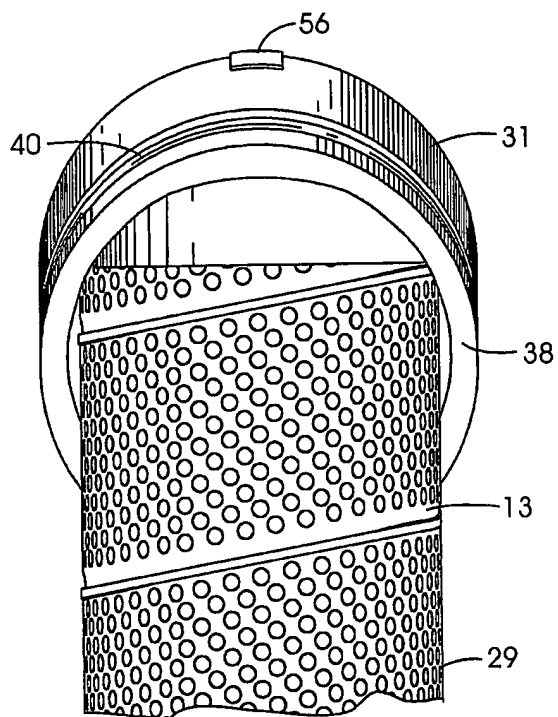


FIG. 4

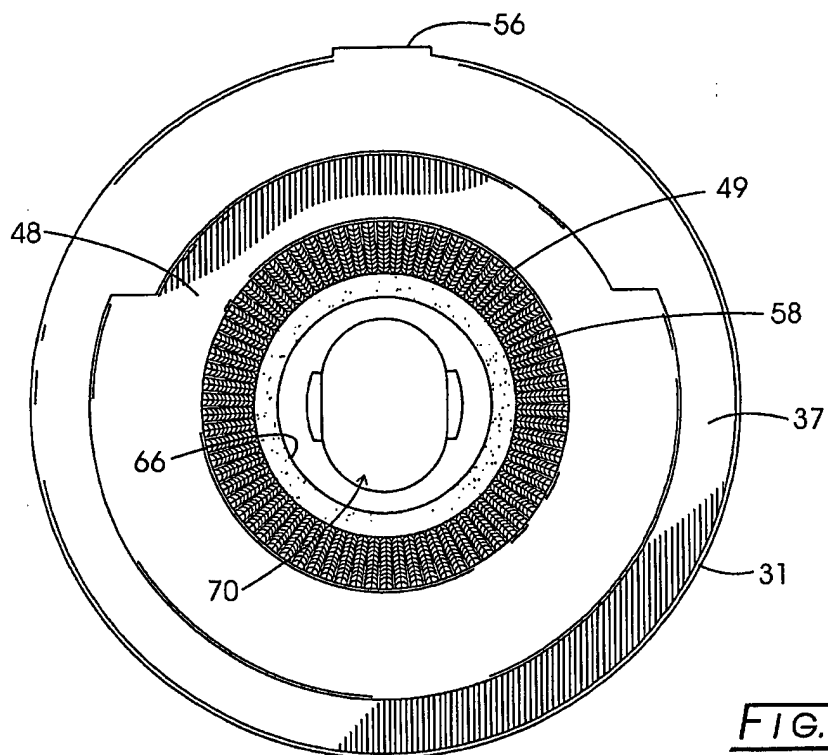


FIG. 5

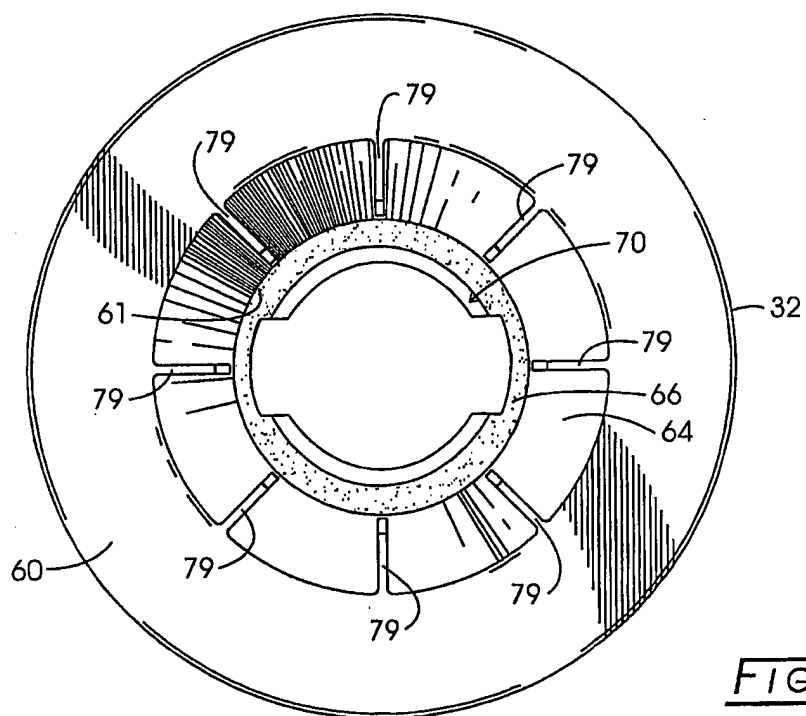
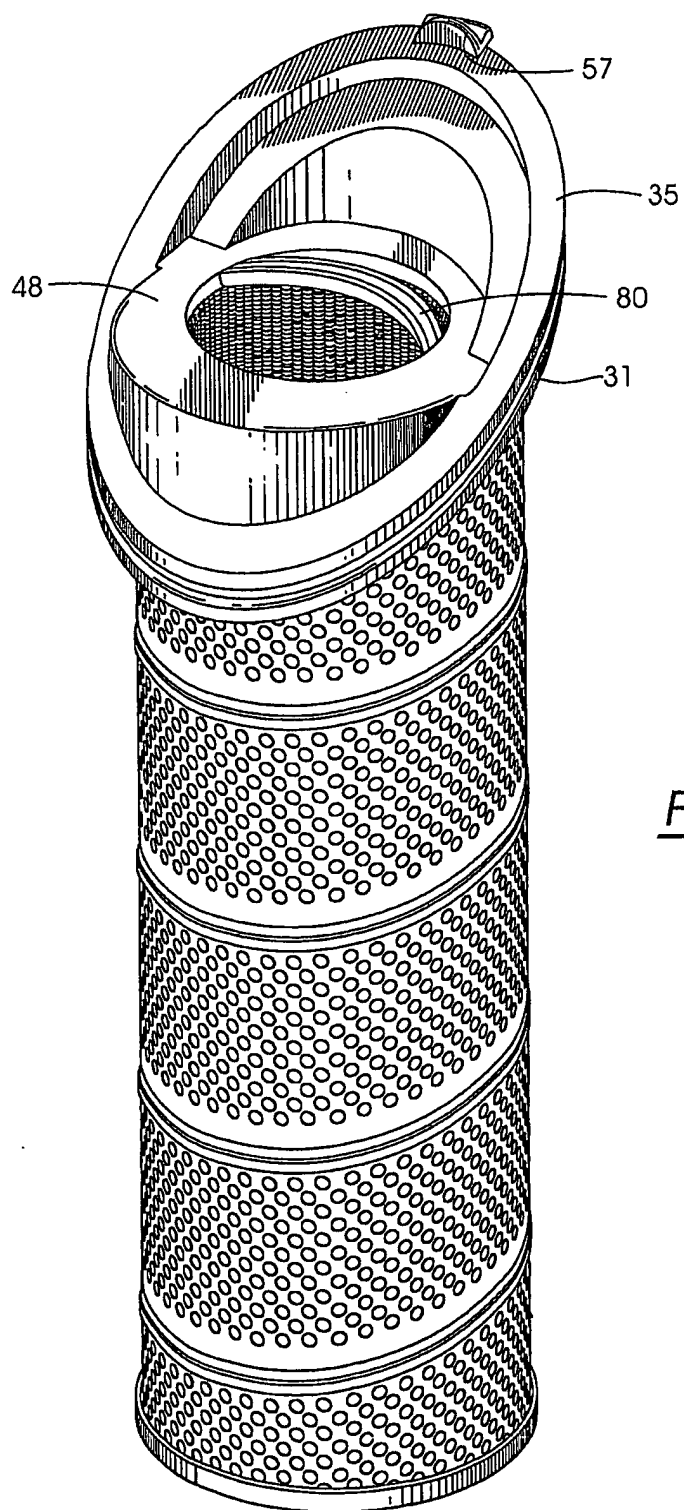


FIG. 6

FIG. 7

# INTERNATIONAL SEARCH REPORT

PCT/US2005/013169

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 7 B01D29/23		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC 7 B01D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3 502 220 A (LAWRENCE F. KOHLBERG) 24 March 1970 (1970-03-24) column 2, line 55 - column 3, line 14; figure 1	1-3,6,8, 10
Y	US 2 915 188 A (BUKER EDWARD) 1 December 1959 (1959-12-01) column 3, line 26 - column 4, line 51; figure 3	1-3,6,8, 10
A	US 908 308 A (H. MUELLER) 29 December 1908 (1908-12-29) page 1, line 93 - page 2, line 8; figure 1	
A	GB 970 826 A (LANCASTER AND TONGE LIMITED) 23 September 1964 (1964-09-23) page 1, line 56 - line 59; figure 1	
-/--		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <span style="margin-left: 100px;"><input checked="" type="checkbox"/> Patent family members are listed in annex.</span>		
<b>* Special categories of cited documents:</b> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>'A' document defining the general state of the art which is not considered to be of particular relevance</p> <p>'E' earlier document but published on or after the international filing date</p> <p>'L' document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>'O' document referring to an oral disclosure, use, exhibition or other means</p> <p>'P' document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>'T' later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>'X' document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>'Y' document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>'&amp;' document member of the same patent family</p> </div> </div>		
Date of the actual completion of the international search <div style="text-align: center; font-weight: bold;">8 September 2005</div>		Date of mailing of the international search report <div style="text-align: center; font-weight: bold;">19/09/2005</div>
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel: (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer <div style="text-align: center; font-weight: bold;">Sembritzki, T</div>

# INTERNATIONAL SEARCH REPORT

PCT/US2005/013169

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 2 712 871 A (SCHMID JOHN H)  12 July 1955 (1955-07-12)  column 2, line 38 - line 52; figure 3  -----</p>	



# INTERNATIONAL SEARCH REPORT

PCT/US2005/013169

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 3502220	A	24-03-1970	NONE	
US 2915188	A	01-12-1959	NONE	
US 908308	A		NONE	
GB 970826	A	23-09-1964	NONE	
US 2712871	A	12-07-1955	NONE	